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NOTES ON VITAMIN UNITS

By Hazel E. Munsell

The present situation in regard to vitamin values is in a most confusing state. There are a variety of units in common use and more often than not, no designation is made to indicate which unit is being referred to. Due to the fact that most of them are based on animal behavior it is impossible to establish definite conversion factors for changing from one unit to another. It is hoped that the situation will soon be clarified by the general acceptance of the International Standards proposed by the Permanent Commission on Biological Standardization of the Health Organization of the League of Nations. This commission has already held two conferences on vitamin standards - one in 1931 and one in 1934. At the first conference standards of reference and units provisional for a 2-year period were proposed for vitamins A, B, C, and D. The standards for vitamins B and D were not changed at the 1934 conference but new standards were proposed for vitamins A and C.

Some of the units in more common use are described below. Conversion factors based on the best available estimates are also given. It must be understood, however, that these are only indicative since from the very nature of the units it is impossible to determine any fixed ratio for converting one into another.

VITAMIN A

The Sherman (Munsell) unit is that amount of the vitamin which, when fed daily, just suffices to support a rate of gain of 3 grams per week in a standard test animal (rat) during an experimental feeding period of 4 to 8 weeks. This unit was included in the Tenth Revision of the United States Pharmacopoeia and is referred to as U.S.P.X Sherman vitamin A unit. The American Drug Manufacturers Association also adopted this unit. For this purpose it is designated as A.D.M.A. vitamin A unit.

The International unit (the provisional unit adopted by the 1931 Conference) is the vitamin A activity of 0.001 milligram (1 γ or 1 gamma) of an international standard preparation of carotene (provitamin A). This unit was adopted by the United States Pharmacopoeial Advisory Board for the Interim Revision of the United States Pharmacopoeia vitamin A method and may be referred to as new U.S.P. or U.S.P.X - Rev. 1934 vitamin A unit.

One U.S.P.X Sherman or A.D.M.A. unit approximates 1.4 International (1931) units.

The new vitamin A unit adopted by the 1934 International Conference is the activity of 0.6 γ of β -carotene. This amount of β -carotene has the same biological activity as 1 gamma of the original International Standard Carotene.

VITAMIN B

The Sherman-Chase unit for vitamin B is that amount of the vitamin which when fed daily will induce a gain of 3 grams per week in a standard test animal during a test period of 4 to 8 weeks.

The International unit is the antineuritic activity of 10 milligrams of an international standard adsorption product of rice polishings prepared by the Seidell method.

VITAMIN C

The Sherman unit is that amount of the vitamin which when fed daily will protect a 300-gram guinea pig from scurvy during a period of 90 days.

The International unit - The unit adopted at the 1931 Conference was the activity of 0.1 cc. of fresh lemon juice. It was soon recognized that this unit was entirely unsuitable due to the variable potency of lemon juice. At the 1934 Conference the activity of 0.65 milligram L-ascorbic acid was selected as the unit. This amount of ascorbic acid has the same biological activity of 0.1 cc. lemon juice.

One Sherman unit equals 15 International (1931) units.

VITAMIN D

The Steenbock unit is the total amount of vitamin D which will produce a narrow line of calcium deposit in the rachitic metaphyses of the distal ends of the radii and ulnae of standard rachitic rats in a period of 10 days.

The A.D.M.A. unit (American Drug Manufacturers Association) is the average daily amount (of vitamin D) required to produce, in 60 percent of the animals in any one group, a degree of recalcification represented by a narrow continuous line across the metaphysis of the leg bones of the rats which have been kept and fed under the conditions as specified in the assay. The average daily dose is understood to be the total amount of vitamin D given divided by the length of the test period, 10 days.

The International unit is the vitamin D activity of 1 milligram of the international standard solution of irradiated ergosterol. This unit has been adopted by the Committee on Revision of the United States Pharmacopoeia and is referred to as "U.S.P. vitamin D unit."

One Steenbock unit equals 2.7 International units.

By definition, 1 Steenbock unit equals 10 A.D.M.A. units. This factor has been extensively used for several years for converting Steenbock units to A.D.M.A. units and vice versa.

In a report of the work of the Pharmacopoeial Vitamin Committee in the American Journal of Pharmacology for December 1933 Professor E. Fullerton Cook gives 1 International unit equal to 3.25 A.D.M.A. units, instead of 3.7 as would be expected from the above relationship. This makes 1 Steenbock unit equivalent to about 8.8 A.D.M.A. units.

The Council on Pharmacy and Chemistry of the American Medical Association adopted the qualifying phrases 250 D, 10 D, etc. to designate vitamin D potency in terms of cod liver oil. The cod liver oil referred to contained 13.3 Steenbock units of vitamin D per gram. By this scheme for instance a solution of viosterol designated as having a potency of 250 D would contain 250×13.3 or 3,333 Steenbock units per gram.

Oslo unit (described by Poulsson, University of Oslo) - The efficacy of a substance is indicated in units per gram on a principle analogous to that used by the United States Pharmacopoeia for vitamin A. From Doctor Poulsson's article, however, it is not clear whether the unit value is that amount which produces complete recovery or a well defined partial recovery.

According to Bills 1 Steenbock unit equals 3 Oslo units.

The Food and Drug Administration of the United States Department of Agriculture gives 1 International unit as equivalent to 1.66 Oslo units or 1 Steenbock unit equals 4.5 Oslo units.

VITAMIN G

The Sherman-Bourquin unit is that amount of vitamin G which when fed daily will give an average gain of 3 grams per week during 8 weeks in addition to any appreciable gain in the group of control test animals on the vitamin G free ration.

EXPRESSING VITAMIN POTENCY

The vitamin potency of an unknown in units per gram is derived by using the expression $1/R$. R equals the amount of the unknown ascertained by experiment to contain one unit.

INTERNATIONAL STANDARDS OF REFERENCE

The International Standards and samples of Reference Cod Liver Oil to be used in assay work are available to scientific laboratories and research workers. Application for these should be made either to Dr. E.M. Nelson, Bureau of Chemistry and Soils, United States Department of Agriculture, or to the United States Pharmacopoeial Vitamin Advisory Board, 43rd Street and Woodland Avenue, Philadelphia.

U.S.P. REQUIREMENTS FOR COD LIVER OIL - INTERIM REVISION

Vitamin A - at least 600 U.S.P.X - Rev. 1934 (International) units or 426 U.S.P.X Sherman units per gram.

Vitamin D - at least 85 U.S.P. (International) units per gram. This value is equivalent to 31.5 Steenbock units, 276 A.D.M.A. units, or 141 Oslo units.